

Appl. No. 10/727,790  
Examiner: IVEY, ELIZABETH D, Art Unit 1775  
In response to the Office Action dated July 12, 2005

Date: October 12, 2005  
Attorney Docket No. 10113391

## REMARKS

Applicant thanks the Examiner for acknowledging Applicant's claim to foreign priority and receipt of the certified copy of the priority document. Responsive to the Office Action mailed on July 12, 2005 in the above-referenced application, Applicant respectfully requests amendment of the above-identified application in the manner identified above and that the patent be granted in view of the arguments presented. No new matter has been added by this amendment.

### Present Status of Application

Claim 1 is rejected under 35 U.S.C. 102(a) as being anticipated by Gutsche (US 2002/0173163). Claims 4-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gutsche. Claims 2-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gutsche in view of Collins et al (US 4,666,557). Claims 10-23 are withdrawn from consideration.

In this paper, claim 1 is amended to include the limitations of claim 7. Claims 4 and 8-9 are amended to correspond with the amendment of claim 1. Claims 2-3, 7, and 10-23 are canceled without prejudice. Thus, on entry of this amendment, claims 1, 4-6 and 8-9 remain in the application.

Reconsideration of this application is respectfully requested in light of the amendments and the remarks contained below.

### Election/Restriction

Applicant affirms the election of Group I without traverse. In view of the Examiner's earlier restriction requirement, Applicant retains the right to present all non-elected claims in a divisional application(s).

### Rejections Under 35 U.S.C. 103(a)

As amended, claim 1 incorporates all of the limitations of original claims 1 and 7, and therefore stands rejected under 35 U.S.C. 103(a) as being unpatentable over Gutsche in view of Collins et al. Applicant respectfully traverses the rejections for the reasons as follow.

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The present invention is directed to a multi-layer hard-mask structure that obtains the advantage of improved boron atom concentration uniformity after annealing. This allows for easier removal of the hard mask layer after a step of etching is completed. In particular, the invention is directed to solving the problem of the formation of a practically undoped region at the bottom portion of the hard mask during an annealing step. It is noted that removal of such a region after etching is difficult and may result in undercutting. See page 3, lines 12-27 and page 11, lines 1-18 of the specification.

A preferred embodiment of the multi-layer hard mask structure recited in claim 1 comprises a first hard mask layer composed of a first boro-silicate glass layer and an overlying first undoped silicon glass layer and at least one second hard mask layer disposed on the first hard mask layer, which is composed of a second boro-silicate glass and an overlying second undoped silicon glass layer, wherein a doping concentration of the first boro-silicate glass layer is higher than that of the second boro-silicate glass layer.

The undoped silicon glass layers serve as diffusion barrier layers, preventing continuous upward diffusion of boron atoms during annealing. The higher doping concentration of the first boro-silicate glass layer relative to the second boro-silicate glass layer further maintains boron atom uniformity in the hard mask structure during and after annealing. See page 11, lines 18-27 of the specification. Together, these features of the hard mask layer of claim 1 prevent the formation of a practically undoped region near the bottom of the hard mask structure. See page 9, lines 22-26 of the specification.

There is no motivation to combine Gutsche and Collins et al to obtain a multi-layer hard mask structure comprising a first hard mask layer composed of a first boro-silicate glass layer and an overlying first undoped silicon glass layer and at least one second hard mask layer disposed on the first hard mask layer, which is composed of a second boro-silicate glass and an overlying second undoped silicon glass layer, wherein a doping concentration of the first boro-silicate glass layer is higher than that of the second boro-silicate glass layer, as recited in claim 1.

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MPEP 2142 reads in part:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In connection with the first criteria of the *prima facie* case of obviousness, MPEP 2143.01 states that the prior art must teach the desirability of the claimed invention.

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)

Gutsche teaches a hard-mask comprising multiple alternating layers, where the layers may comprise boro-silicate glass. As acknowledged by the Examiner, Gutsche does not teach either the specific layer thicknesses or the doping concentrations recited in the claims. Furthermore, Gutsche is silent with respect to the problem of continuous upward diffusion of boron atoms during annealing and the resultant formation of a practically undoped region near the bottom of the hard mask structure.

Collins et al teach that the thickness and doping level of a boro-silicate glass layer 49 is chosen in conjunction with the time/temperature product of a subsequent drive-in into the silicon substrate on which the layer is disposed in order to control the concentration of the resulting channel stops. See column 4, line 67 to column 5, line 3 of Collins et al.

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More specifically, it is noted that in Collins et al, a single boro-silicate glass layer 49 is disposed on the substrate. It is further noted that the thickness and doping level of this single layer is chosen in order to obtain desired concentration of the channel stops after a lateral drive-in of the boron dopant into the silicon trench sidewalls 46. See column 5, lines 39-43 of Collins et al.

Applicant submits that nothing in the prior art teaches the *desirability* of modifying the teaching of Gutsche to obtain a structure in which a doping concentration of a first boro-silicate glass layer is higher than that of a second boro-silicate glass layer in a multi-layer hard mask as recited in claim 1, as required to establish a *prima facie* case of obviousness.

Namely, Gutsche is entirely silent on the topic of doping concentrations of the layers and the problem of boron upward diffusion during annealing. Furthermore, while Collins et al teach the thickness and doping level of a single boro-silicate glass layer may be chosen in order to obtain a desired concentration of the channel stops after a lateral drive-in of boron dopant into silicon trench sidewalls, ***there is no teaching of choosing the doping level of a first boro-silicate glass layer relative to a second boro-silicate glass layer, let alone the desirability of such a configuration.***

Indeed, the only teaching of the desirability of a multi-layer hard mask structure comprising a first hard mask layer composed of a first boro-silicate glass layer and an overlying first undoped silicon glass layer and at least one second hard mask layer disposed on the first hard mask layer, which is composed of a second boro-silicate glass and an overlying second undoped silicon glass layer, wherein a doping concentration of the first boro-silicate glass layer is higher than that of the second boro-silicate glass layer, comes from Applicant's own disclosure.

With respect to the Examiner's position that it would have been obvious to one having ordinary skill in the art to adjust the thickness of the layers and doping concentrations of the boro-silicate glass layers for the intended application since it has been held that "discovering an optimum value of a result effective variable involves only routine skill in the art," Applicant notes that ***it is Applicant's own disclosure, not the prior art, that teaches the problem to which the recited "optimum" thicknesses and doping concentrations of the layers are directed.***

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Stated differently, the "optimum value" to which the Examiner refers is relative to the problem identified and solved by the instant invention. Absent the problem, there is nothing in the prior art relied upon in the rejections that would lead a person of ordinary skill to modify the multi-layer mask of Gutsche to obtain the structure recited in claim 1. Certainly, the teaching of Collins et al, which is directed to a single boro-silicate layer disposed in an entirely different structure and optimized in thickness and doping concentration for the purpose of driving boron atoms into an adjacent substrate, fails to do so.

For at least the reasons described above, it is Applicant's belief that a *prima facie* case of obviousness cannot be established in connection with claim 1. Furthermore, as it is Applicant's belief that a *prima facie* case of obviousness is not established for claim 1, the Examiner's arguments in regard to the dependent claims are considered moot and are not addressed here.

Nevertheless, Applicant takes this opportunity to note that the Examiner's arguments in connection with claims 4-6 are considered defective for reasons similar to those discussed in the previous paragraphs. Namely, the dimensions recited in claims 4-6 are optimal values relative to the problem identified and solved by the instant invention. Absent the problem, there is nothing in the prior art relied upon in the rejections that would lead a person of ordinary skill to modify the multi-layer mask of Gutsche to obtain these values.

Allowance of all claims pending claims is respectfully requested.

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Conclusion

The Applicant believes that the application is now in condition for allowance and respectfully requests so.

Respectfully submitted,



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Nelson A. Quintero  
Reg. No. 52,143  
Customer No. 34,283  
Telephone: (310) 401-6180

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